LimnoTech
Water Environment | Scientists Engineers

Michigan's Statewide PCB TMDL

Public Meeting

February 6, 2013

Moderator

Marcy Knoll, DEQ

Presenter

Dave Dilks, LimnoTech

- LimnoTech and DEQ Panel

Penelope Moskus
LimnoTech

Sylvia Heaton
DEQ

Joy Taylor Morgan
DEQ

Gary Kohlhepp
DEQ

Objectives

- Overview of Total Maximum Daily Loads (TMDLs)
- Overview of PCB impairment across Michigan
- Overview of draft statewide PCB TMDL development
- Receive comments on draft TMDL

Objectives

- Overview of Total Maximum Daily Loads (TMDLs)
- Overview of PCB impairment across Michigan
- Overview of draft statewide PCB TMDL development
- Receive comments on draft TMDL

What is a Total Maximum Daily Load (TMDL)?

- Requirement of the Federal Clean Water Act
  - Section 303(d)
- States are required to:
  - List waters not attaining water quality standards
  - Define the amount of pollutant that a water body can receive and still meet water quality standards
    - This amount is defined as a Total Maximum Daily Load
    - Also referred to as maximum allowable load, loading capacity

Background on Total Maximum Daily Loads (TMDLs)

- State assesses waters every two years
  - Determine if a water body is impaired and identify designated uses not being met
  - Identify causes when a water body is impaired (chemical, biological or physical)
  - Indicate possible sources that are contributing to the impairment

Objectives

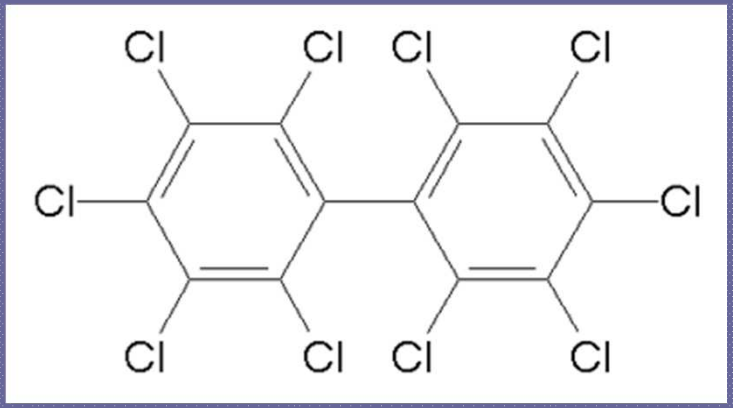
- Overview of Total Maximum Daily Loads (TMDLs)
- Overview of PCB impairment across Michigan
- Overview of draft statewide PCB TMDL development
- Receive comments on draft TMDL

PCB Impairments across Michigan
What are PCBs?

- PCB = polychlorinated biphenyl
  - synthetic, chlorinated organic chemicals
  - produced mainly for their insulating capabilities and chemical stability
- Banned from production in 1979
- Cause a variety of health effects
  - impacts to the nervous, immune, reproductive, and endocrine systems
  - cancer

PCB Impairments Across Michigan
What are PCBs?

- Chemical nature of PCBs makes them an environmental issue, even though their production has long been banned
  - Chemical stability makes them long-lasting in the environment
  - Strong tendency to accumulate in fish tissue



PCB Sources

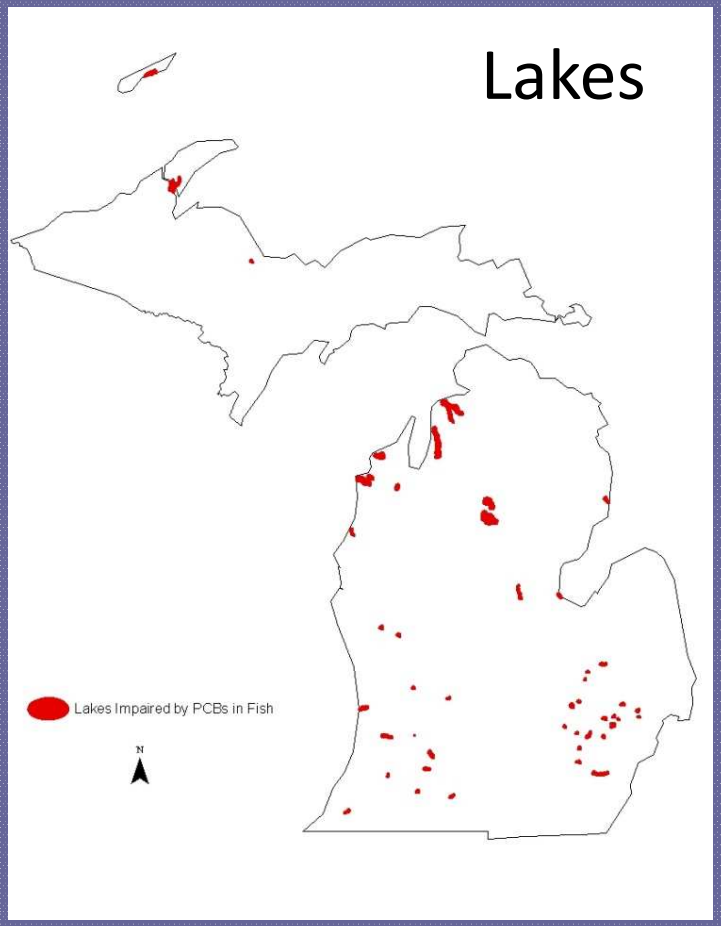
- PCBs are a man-made compound, with no natural sources
- PCBs enter Michigan waters primarily from the atmosphere and via runoff
- Sources to the atmosphere consist primarily of remnants from past PCB uses
  - Capacitors, transformers, and other electrical equipment
  - Often accumulated in landfills, scrap yards

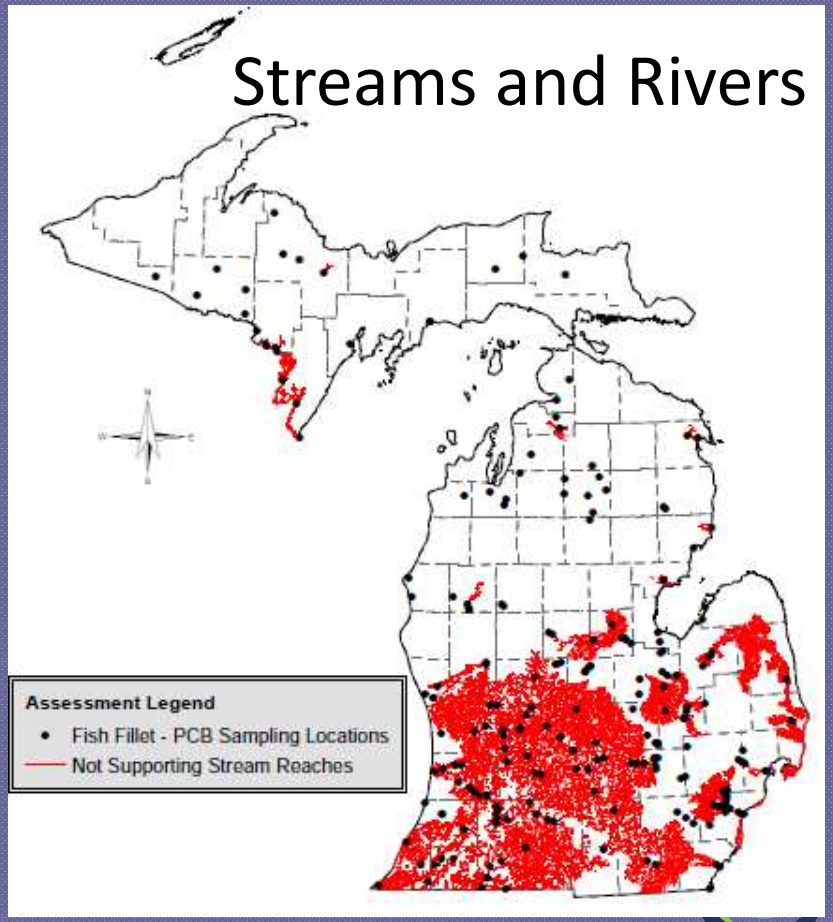
PCB Impairments to Designated Uses

- PCB impairments assessed in two ways
  - Other Indigenous Aquatic Life and Wildlife Use
    - Water column concentration exceeds water quality standards
  - Fish Consumption Use
    - Water column concentration exceeds water quality standard
    - Fish tissue concentration exceeds Michigan Department of Community Health (MDCH) trigger levels
    - Issuance of fish consumption advisories

PCB Impairments Based on Fish Tissue

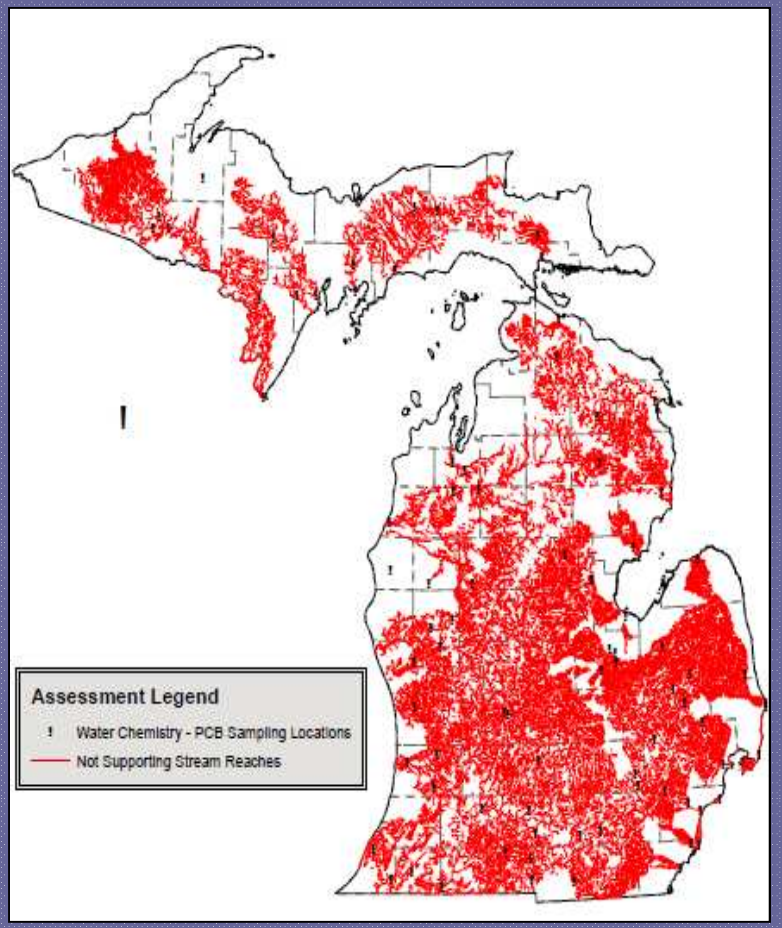
1,141 water body segments out of 3,217 assessed units are impaired due to PCBs in fish tissue





PCB Impairments Based on Water Concentration

2,137 water body segments out of 3,217 assessed units are impaired due to PCBs in the water



PCB Impairments:
Average Concentration by Fish Species

Species	Average Concentration (mg/kg)
Black Crappie	0.073
Brook Trout	0.072
Brown Bullhead	0.006
Brown Trout	0.159
Carp	0.641
Channel Catfish	0.260
Freshwater Drum	0.267
Lake Herring	0.001
Lake Trout	0.147
Lake Whitefish	0.058
Largemouth Bass	0.034
Northern Pike	0.058

Species	Average Concentration (mg/kg)
Pumpkinseed	0.060
Rainbow Trout	0.020
Redhorse Sucker	0.091
Rock Bass	0.102
Smallmouth Bass	0.106
Splake	0.004
Walleye	0.125
White Bass	1.106
White Sucker	0.179
Yellow Bullhead	0.003
Yellow Perch	0.026

Red values exceed target of 0.023 mg/kg

Objectives

- Overview of Total Maximum Daily Loads (TMDLs)
- Overview of PCB impairment across Michigan
- Overview of draft statewide PCB TMDL development
- Receive comments on draft TMDL

TMDL Development

- Define Waters to be Addressed
- Determine Numeric TMDL Target
  - How much can we have and not impair designated uses?
- Loading Capacity
  - What is the maximum load that will attain the target?
- Allocate Allowable Load
  - How much does each contributing source need to be reduced?

TMDL Development: Waters to be Addressed

- TMDL focused on inland waters impaired primarily by atmospheric sources
- Waters *not* covered by the TMDL
  - Great Lakes and connecting channels
    - Great Lakes will be covered in a separate TMDL
  - Legacy sites
    - Sediment remediation activities will continue to address legacy site contamination

TMDL Development

- Define waters to be addressed
- Determine Numeric TMDL Target
  - How much can we have and not impair designated uses?
- Loading Capacity
  - What is the maximum load that will attain the target?
- Allocate Allowable Load
  - How much does each contributing source need to be reduced?

Numeric TMDL Target: Defines acceptable water quality

- TMDL targets must be expressed at a level to demonstrate attainment of State water quality standards
- Water quality standards can be described in either of two forms
  - Numeric criteria
  - Narrative standards

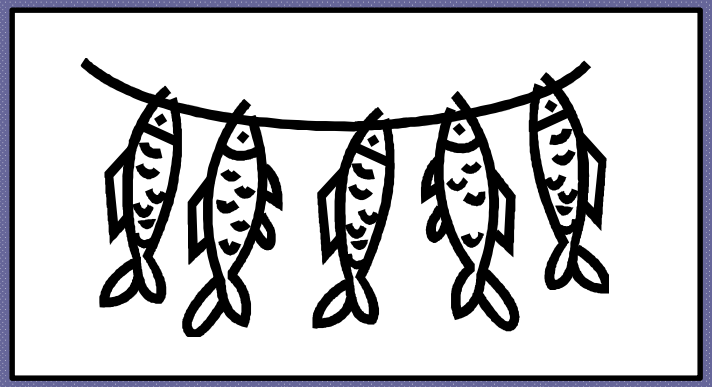
Numeric TMDL Target: Defines acceptable water quality

- Two numeric criteria exist for PCBs
  - Wildlife Value of 0.12 ng/L
  - Human Cancer Value, 0.026 ng/L

- Narrative Standard – R323.1057 (Toxic Substances)
  - "Toxic substances shall not be present in the surface waters of the state at levels that are or may become injurious to the public health, safety, or welfare, plant and animal life, or the designated uses of the waters."
    - Fish tissue PCB concentration of 0.023 mg/kg to interpret the narrative standard

Numeric TMDL Target: Defines acceptable water quality

- TMDL target set at fish tissue PCB concentration of 0.023 mg/kg
  - Consumption of fish by humans is the most significant route of exposure
  - Fish tissue target is consistent with the water quality standards



TMDL Development

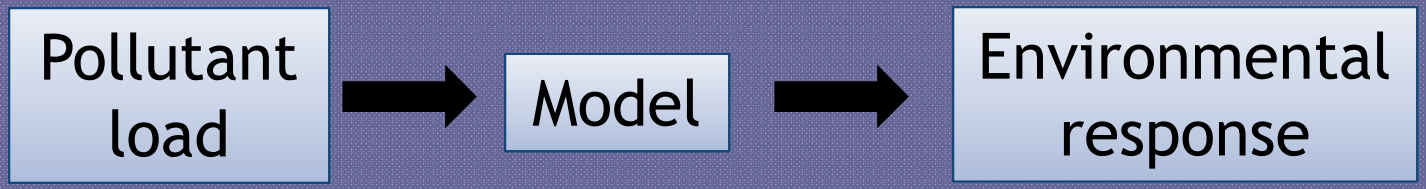
- Define waters to be addressed
- Determine Numeric TMDL Target
  - How much can we have and not impair designated uses?
- Loading Capacity
  - What is the maximum load that will attain the target?
- Allocate Allowable Load
  - How much does each contributing source need to be reduced?

TMDL Development: Modeling

- TMDL is the maximum pollutant load that will attain water quality standards
  - Development of a TMDL requires a means to relate pollutant loading to environmental response
  - This relationship is defined using a water quality model
    - Model is mathematical equation linking pollutant load to environmental response

TMDL Development: Modeling

- A Model is a mathematical equation linking pollutant load to environmental response



- Model development requires two steps
  - Characterize pollutant load
  - Link pollutant load to environmental response

TMDL Development: Modeling

- Atmospheric PCBs can be delivered to water bodies by three mechanisms
  - Gas exchange
  - Wet deposition
  - Dry deposition

- Scientific literature shows that gas exchange is the dominant mechanism
  - PCB load in model is represented by atmospheric gas phase concentration

TMDL Development: Linking PCB Loading to Environmental Response

- Many types of models exist for relating pollutant load to concentration
- A common approach is a simple proportionality model
  - PCB concentration in fish = a x PCB load
    - "a" is defined as a proportionality constant

TMDL Development:
Calculating Maximum Allowable Load

- Maximum allowable load can be calculated by rearranging model equation

PCB concentration in fish = a * PCB load

PCB load = PCB concentration in fish ÷ a

Maximum allowable PCB load =

Target PCB concentration in fish ÷ $a_{threshold}$

$a_{threshold}$ = threshold proportionality constant

TMDL Development:
Determination of Threshold Proportionality Constant

- Proportionality Constant varies from lake to lake and species to species
  - How do we select an appropriate value for a statewide TMDL?
- Follow precedent set by other statewide TMDLs
  - Select a target fish species
  - Select a target percentile

TMDL Development: Selection of a Target Fish Species

- Lake trout selected as target fish species
  - Top level predator
    - Consistent with the trophic level of fish used to derive the Human Cancer Value water quality criterion
  - High PCB tissue levels in lake trout

TMDL Development: Selection of a Target Percentile

- Not necessarily feasible to base statewide reductions on the single highest fish tissue PCB concentration
- 90th percentile fish tissue PCB concentration on which to base reductions
  - Allows for outlier water bodies that may have unique circumstances
  - Consistent with other statewide TMDLs

TMDL Development: Loading Capacity Calculation

- Determine allowable load by defining threshold proportionality constant
  - Calculate proportionality constant for each water body where lake trout PCB tissue data exist
    - a = PCB concentration in fish ÷ PCB load
  - Conduct statistical analysis to define the 90th percentile value
    - $a_{threshold}$ = 3.293 (mg/kg)/(ng/m^3)

TMDL Development: Loading Capacity Calculation

- Maximum allowable PCB load =

  Target PCB concentration in fish ÷ $a_{threshold}$

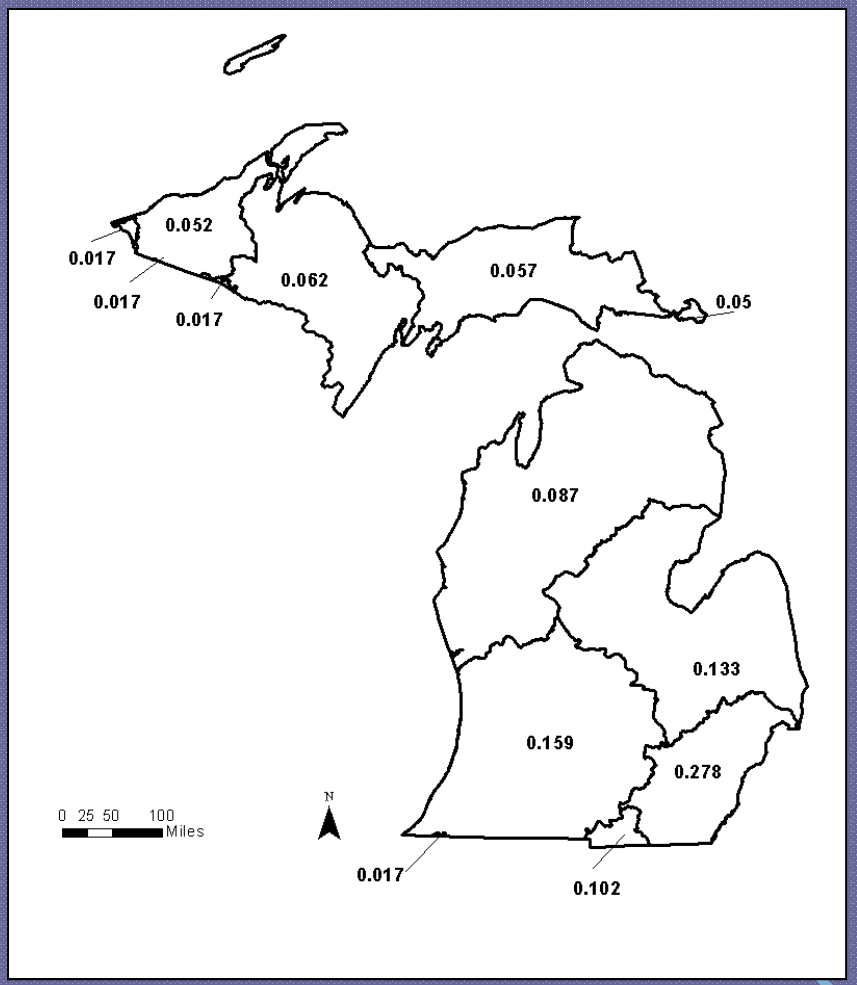
  - PCB load = 0.023 ÷ 3.293 = 0.007 ng/m^3

- Determine necessary reduction percentage
  - Compare allowable load to existing load

TMDL Development: Determination of Existing Load

Venier and Hites (2010) calculated atmospheric PCB concentrations across the Great Lakes region

- Statewide average PCB concentration = 0.115 ng/m^3



TMDL Development: Determination of Necessary Reduction Percentage

Current PCB load = 0.115 ng/m^3

Maximum allowable PCB load = 0.007 ng/m^3

Necessary reduction percentage =

(0.115- 0.007) / 0.115 = 94%

TMDL Development

- Define waters to be addressed
- Determine Numeric TMDL Target
  - How much can we have and not impair designated uses?
- Loading Capacity
  - What is the maximum load that will attain the target?
- Allocate Allowable Load
  - How much does each contributing source need to be reduced?

Components of a TMDL: Allocations

$$TMDL=\Sigma WLA+\Sigma LA+MOS$$

- *TMDL process requires that the overall load be divided into three categories*
  - Wasteload allocations (WLA): Point source loads
  - Load allocations (LA): Nonpoint source loads
    - This TMDL is unique in that it focuses solely on waters primarily impaired by atmospheric deposition
  - Margin of safety (MOS)
    - Account for uncertainties in the relationship between pollutant loading and receiving water quality

Allocation: Components of a TMDL

- Wasteload allocations (WLA)
  - Require all NPDES permitted point sources to meet water quality standards
- Load allocations (LA)
  - 94% reduction in nonpoint sources (i.e., atmospheric sources)
- Margin of safety (MOS)
  - TMDL contains *implicit* margin of safety
    - Reductions based on species with high levels of PCBs
    - Conservative assumptions in modeling

Calculation of Maximum Daily Load

- Water quality model used for TMDL is based on annual average atmospheric concentrations
  - Fish tissue concentration responds very slowly to changes in atmospheric concentration
- TMDLs should define "daily" maximum load
  - Seasonal variability in PCB concentrations examined
  - PCB concentration vary with temperature
    - Calculated PCB concentration associated with average daily maximum temperature in each EDU
  - 0.034 ng/m^3 is the highest daily value expected to occur for an annual average of 0.007 ng/m^3

Allocation: Components of a TMDL

Summary of Michigan's Statewide PCB TMDL

TMDL Components	Units	Statewide
Target Level and Reduction Factor		
Target Fish PCB Concentration (Fish Tissue Residue Value)	mg/kg	0.023
PCB Concentration for Standard Length Lake Trout	mg/kg	0.378
Reduction Factor	94%	
PCB Load for Baseline Year 2010		
Point Source Load	lbs/day	1.57E-06
Maximum Daily Nonpoint Source Concentration	ng/m^3	0.571
Final TMDL		
Margin of Safety	Implicit	
Wasteload Allocation (WLA)	lbs/day	1.57E-06
Load Allocation (LA) (Maximum Daily Concentration Used as a Surrogate)	ng/m^3	0.034
PCB Load Allocation for In-State and Out-of-State Deposition Sources		
In-State Contribution to LA		45%
Out-of-State Contribution to LA		55%
Necessary Reduction from Anthropogenic Emission Sources for both In-State and Out-of-State Contribution		94%

Implementation

- How do we obtain the necessary reductions?
  - Unlike point source discharges to water, there are no direct regulatory controls on fugitive atmospheric sources of PCBs (i.e., nonpoint sources)
- Implementation actions
  - Clean-Up of Legacy Sources
  - Restriction of Landfill Disposal of PCBs
  - Regulations Governing Transport of PCBs
  - Federal Toxic Substances Control Act (TSCA)

Implementation Actions

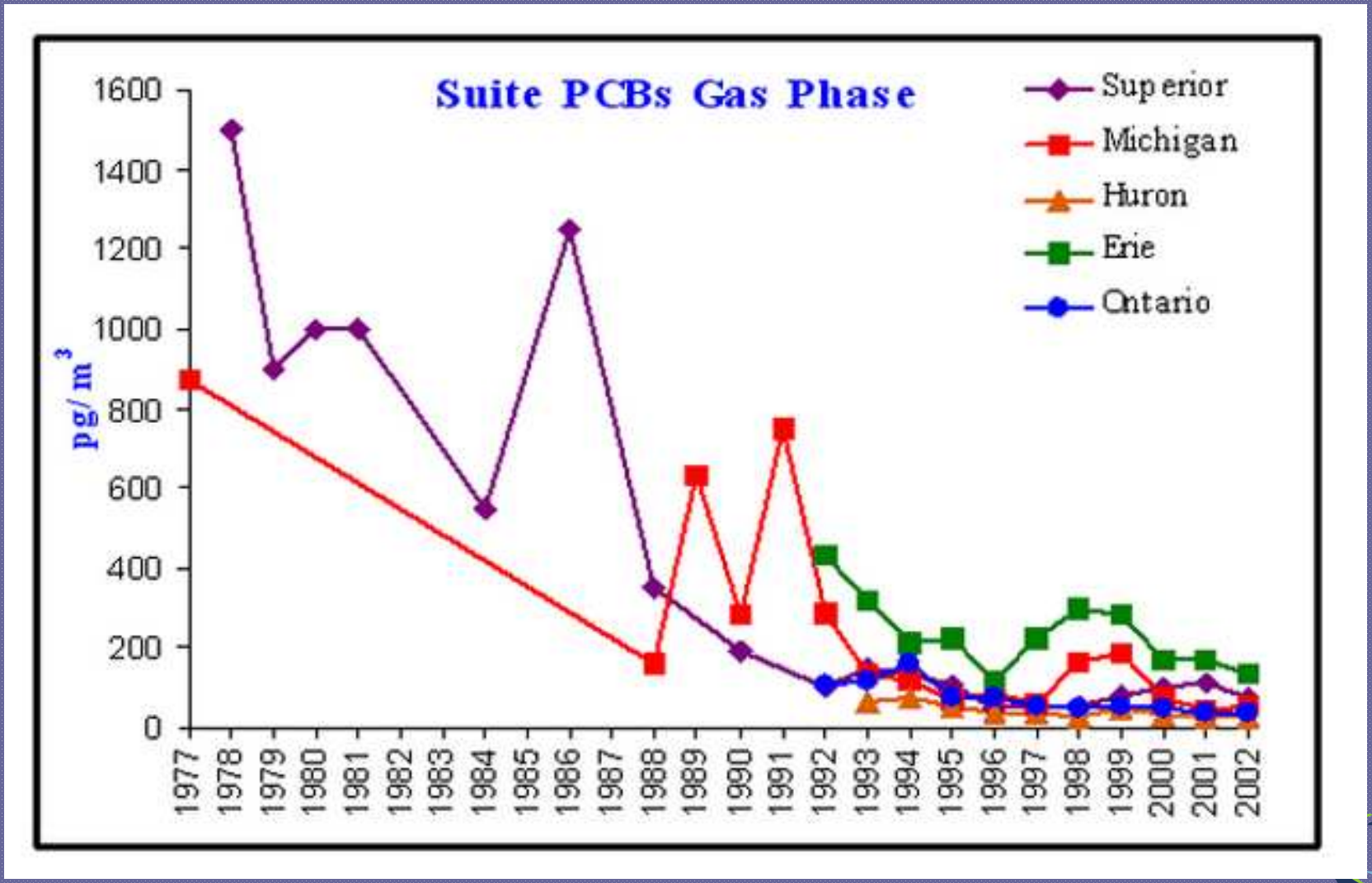
- Clean-Up of Legacy Sources
  - Formal clean-up plans are in place at several sites influenced by legacy sources and will continue
    - Great Lakes Legacy Act, Superfund legislation, Great Lakes Restoration Initiative, Binational Toxics Strategy
- Restriction of Landfill Disposal of PCBs
  - Michigan's Natural Resources and Environmental Protection Act prohibits disposal of PCBs in most landfills

Implementation Actions

- Regulations Governing Transport of PCBs
  - Michigan regulations now require the use of uniform hazardous waste manifests for all regulated shipments of PCB
- Federal Toxic Substances Control Act (TSCA)
  - Federal legislation regulating all aspects of PCB use

Effects of Implementation Activities

Atmospheric concentrations are decreasing



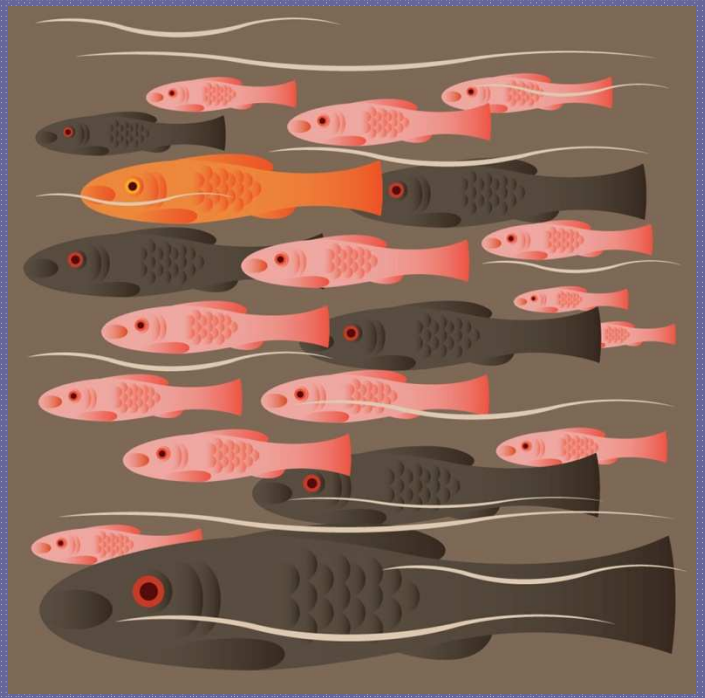
Effects of Implementation Activities

PCB fish tissue concentrations are decreasing

Water Body	Species	Rate of Change (%/year)	P Value
Inland Rivers			
Grand River	Carp	-3.1	<0.005
Kalamazoo River	Carp	-7.2	<0.001
Muskegon River	Carp	-13.4	<0.001
River Raisin	Carp	-14.1	<0.001
St. Joseph River	Carp	-2.9	<0.05
Inland Lakes			
Lake Gogebic	Walleye	-15.9	<0.001
South Manistique Lake	Walleye	-4.3	<0.001
Higgins Lake	Lake Trout	-10.3	<0.001
Houghton Lake	Largemouth Bass	-12.1	<0.001
Gull Lake	Largemouth Bass	-6.4	<0.001
Gun Lake	Largemouth Bass	-6.3	<0.001
Pontiac Lake	Largemouth Bass	-6.0	<0.005
	Average	-8.5	
	Median	-6.8	

Summary

- Trying to control a cat that is already out of the bag
- Actions are being taken to control ongoing sources
- Improvements are clearly being seen
- It is going to take time to achieve fish tissue targets statewide that relate to atmospheric sources of PCBs



Objectives

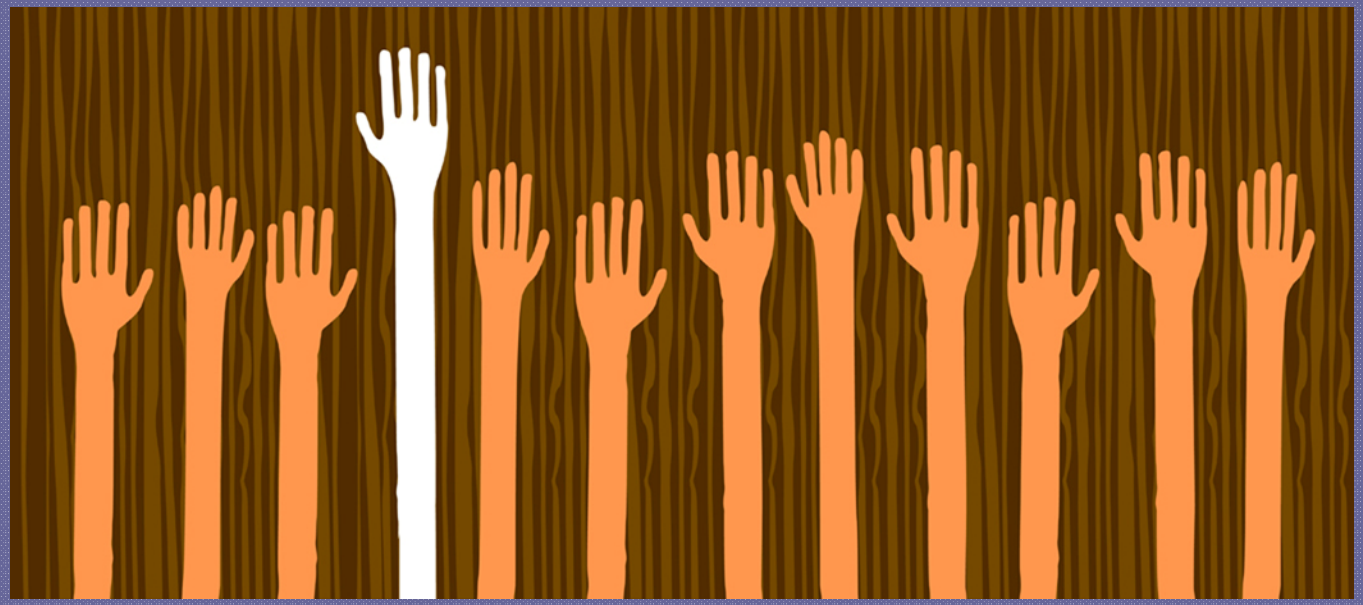
- Overview of Total Maximum Daily Loads (TMDLs)
- Overview of PCB impairment across Michigan
- Overview of draft statewide PCB TMDL development
- Receive comments on draft TMDL

Public Participation/Involvement

Written comments are being accepted until February 19, 2013. Please submit comments on the draft PCB TMDL to:

Ms. Marcy Knoll
Department of Environmental Quality
Water Resources Division
P.O. Box 30458
Lansing, MI 48909-7958

Questions or Comments on Today's Presentation?



For additional information

Michigan DEQ website:

www.michigan.gov/waterquality

Contact Marcy Knoll, Michigan DEQ

517-335-7360

knollm@michigan.gov

Contact Dave Dilks or Penelope Moskus, LimnoTech

734-332-1200

ddilks@limno.com

pmoskus@limno.com